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(54) INFRARED RADIATION COMMUNICATION SYSTEM

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This invention refers to an infrared radiation communication system with two-way voice-controlled communication equipment in which infrared radiation is used as a transmission medium.

The object of the invention is to enable voice communication at comparatively short distances and in an extremely noisy environment, for example in a factory or in comection with utilizing work machines. In accordance with the invention this is carried out by means of headsets comprising in combination infrared radiation receivers, loudspeakers, microphones and transmitters. Previously existing systems of similar type have operated with a stationary transmitting station, and it is now the first time that the headset also is utilized as a transmitter.

An object of the invention is to provide omnidirectional characteristics for voice transmission and voice reception by means of infrared radiation. In accordance with the invention, it hereby becomes possible to select the range in the interval of 4-11 meters, for instance by strapping. It is also an object in accordance with the invention to adjust the threshold value for voice transmission automatically to the noise level of the environment. Additional objects of the invention are to enable general messages to be received by the receivers of the relevant infrared radiation communication system and to enable the system to cooperate with intercommunication systems. The system of the invention should also be capable of being used for receiving music or speech over a FM loop.

The objects of the invention are realized by an infrared radiation communication apparatus, comprising headset means adapted to be disposed on the head of a person; sensor and receiving means associated with said headset means for automatically sensing and receiving an infrared radiation signal and for providing a signal corresponding thereto; speaker means associated with said headset means and connected to said sensor and receiving means and

The objects set forth by the invention are achieved by the means disclosed in the accompanying claims.

The invention will be described more specifically in the following with reference to the accompanying drawing, in which Figure 1 diagrammatically illustrates a person provided with a headset which is designed in accordance with the invention and Figure 2 shows a block diagram of the communication system in accordance with the invention, with all the components of Figure 2 being adapted to be incorporated in the various portions of Figure 1. The same reference numerals have been utilized in the two figures wherever possible.

Figure 1 indicates a person 1 being provided with a headset 2 including two ear protectors, of which only one, namely 3, is visible, as well as a voice microphone 4 which is connected to said one ear protector 3. The ear protector 3 is a high quality ear protector of standard type, said ear protector having been provided with a built-in loudspeaker which is diagrammatically represented by a small loudspeaker 5. In order to make it possible to utilize ear protectors of standard type these have been provided with a built-on cap 6 of a material which is penetrable by infrared radiation of short wavelength and which contains a microphone 7 for registering noise entering through small apertures (not shown) in the cap, furthermore infrared radiation transmitter diodes 8, and receiver diodes with associated components in accordance with block 9 of Figure 2, in which three diodes 10, 11, and 12, respectively, are shown, which can be positioned in different places on the ear protector so that when actuated by infrared radiation they provide reception of omnidirectional type. Each receiver diode is provided with an individual optical low pass filter 10a, 11a and 12a for eliminating the influence of light waves having shorter wavelengths than the infrared light. Each one of said diodes is connected first

for receiving the signal therefrom and for providing an acoustical signal corresponding to the sensed infrared radiation signal; a voice microphone associated with said headset means and disposed to receive the person's voice and provide a voice signal corresponding thereto; emitting means associated with said headset means and responsive to said voice signal for emitting infrared radiation corresponding to said voice signal; and blocking means responsive to the signal from said sensor and receiving means for blocking said voice signal from reaching said emitting means whenever the infrared radiation signal is sensed, whereby the infrared radiation communication apparatus may not emit infrared radiation when an infrared radiation signal is being sensed and received.

In the system of the invention rechargeable nickel-cadmium batteries may advantageously be utilized. Low frequency disturbances derived from external noise sources, for example incandescent lamps and fluorescent tubes, may be avoided in the system in consequence of use being made of a carrier having a frequency lying over the disturbance frequencies of said noise sources. Furthermore, the power consumption of the infrared radiation-emitting diodes utilized in the system can be decreased by transmitting pulses of short duration and large current instead of pulses of varying width in consequence of the speech frequency modulation in conventional manner, and the result of this will be that the range of the relevant system will be greater than otherwise would be the case.

to an amplifier 13, 14, and 15, respectively, and thereafter to a mixing capacitor 16, 17, and 18, respectively, with the respective output sides of the mixing capacitors being interconnected and being coupled to a common amplifier 19. Unmodulated light signals do not reach amplifier 19 as the result of the mixing capacitors 16, 17, and 18, respectively, only passing modulated signals.

The two ear protectors in each headset are symmetrical, and their electrical circuits are connected by means of leads in the belt of the headset. A transmitter/receiver 20 is connected to one of the ear protectors over a connecting cable 21 and includes batteries, appropriately in the form of nickel-cadmium cells. The operating voltage of transmitter/receiver 20 is maintained constant, and this is done in manner known per se by means of a voltage stabilizer (not shown). The transmitter/receiver may appropriately be provided with a combined on/off switch with a volume control 22.

The block 23 of Figure 2 shows the components included in the transmitter/receiver 20. The mode of operation of these components will be understood from the description of the mode of operation of the communication system which now will follow.

The general function of the transmitter is to amplify both voice and noise levels and to compare the sound pressure at the voice microphone 4 to the sound pressure at the reference noise microphone 7 so as to achieve a well defined threshold for voice control. The higher the noise is, the greater sound pressure is necessary at the voice microphone for initiating voice transmission. Microphone 4 senses both voice and noise from the environment, but this microphone is noise compensated and hence it principally only submits a signal corresponding to the voice (speech). Microphone 7 only senses noise from the environment and is connected to a rectifier 24 for rectifying the noise signal. Sound signals from microphone 4 and from

microphone 7 are more specifically compared in a comparator 25, whose resulting signal is supplied to a bistable flip-flop circuit 26 which cancels the attenuation in an attenuator 27, which when it is attenuated prevents the speech over microphone 4 from passing, and also opens a gate 28. Attenuator 27 is included in a circuit for automatic volume control, and in addition to attenuator 27 this circuit includes a comparator 29. After the voice signal from microphone 4 has passed the circuit for automatic volume control, it reaches a voltage controlled oscillator 30 which oscillates at a constant frequency, concurrently delivering a carrier on which the speech is frequency modulated. The resulting signal is supplied through gate 28, which, as has been mentioned above, already has been opened, to a monostable flip-flop circuit 31, whose purpose is to convert the incoming frequency modulated signal to the desired pulses of short duration. These pulses are forwarded to transmitter diodes 8 over an amplifier 43 which is provided with a constant current generator 43a. Thereby the transmitter power is maintained constant within the operating range of the battery, irrespective of the charge condition of the battery and in spite of the battery voltage decreasing from a maximum value (when the battery is newly charged) to a minimum value (when the charge of the battery has decreased to the permitted lower limit). In this manner, the period during which the battery may be utilized will be extended. Transmitter diodes 8 radiate pulses directionally, and these diodes may appropriately be positioned in such manner on the caps 6 of the ear protectors that the radiation operation will be strongest in the direction in which the face is turned and slightly weaker sidewards and rearwards. However, under all circumstances a radiation of omnidirectional type is achieved by the manner in which the transmitter diodes are disposed in the cap 6.

In order to prevent two or more sets from transmitting simultaneously, which causes an unpleasant

interference signal in the other receivers, the above-mentioned bistable flip-flop circuit 26 has an additional purpose besides the one mentioned above. If a counterpart already is transmitting, the own transmitter cannot deliver a signal in consequence of the carrier sensing flip-flop 32 providing a signal to flip-flop circuit 26 and preventing the latter from being switched to speech position.

In receiving infrared radiation signals, including signals from the own transmitter diodes for enabling listening, the signals are supplied to the receiver diodes 10, 11, and 12, respectively, whereafter the signals are forwarded through the respective amplifiers 13, 14, and 15 and the mixing capacitors 16, 17, and 18, respectively, to the amplifier 19. From the latter, the signal is supplied to two monostable flip-flops 32 and 33 having different time constants. Flip-flop 32 has the purpose of indicating the presence of an incoming carrier, and the function of flip-flop 33 will be described below. The signal derived from flip-flop 32 opens a gate 34 which passes the signal derived from the block 9 to a monostable flip-flop 35 having the purpose of regenerating and extending the incoming signal of short duration and of feeding out the regenerated signal to a demodulator 36 which demodulates the incoming FM modulated signal and supplies its output signal to an attenuator 37 which ensures that the signal does not exceed a predetermined value as a safety measure so that the eardrums of the person carrying the headset will not be injured. The output signal from attenuator 37 is supplied to a terminating stage 38 and is forwarded from there to the above-mentioned loudspeaker 5 which is built in into the ear protector.

The block 23 contains a switch 39 which in its position illustrated in the figure passes the carrier derived from the frequency controlled oscillator 30 to a gate 40 which is open on the condition that no carrier is being received from block 9 over the monostable flip-flop 32. This means that flip-flop 35

will be activated, but nothing else happens. The purpose is to prevent transients from occurring and from being received in the loudspeaker 5 so as to cause unpleasantness to the relevant person.

If the switch 39 is in its other position, a signal is received from a FM loop 41 over an amplifier 42 and is forwarded to gate 40 which sends the signal on to flip-flop 35, whereafter the signal is treated in the manner described above. The FM loop has the purpose of making it possible to receive music or general messages and to forward these to the ear protectors. When the communication over the infrared radiation medium is to be established, it is desired to cut out the music, which is done by gate 40 being closed in consequence of the signal arriving from block 9. This in turn causes the infrared radiation message to be forwarded through gate 34 and the monostable flip-flop 35, etc., whereas the music cannot be heard.

The designation 33 refers to a monostable flip-flop having a very long time constant and having the purpose of disconnecting the music by actuating gate 40 so that only speech via the infrared radiating diodes will be audible.

WE CLAIM:

1. An infrared radiation communication apparatus, comprising:

head set means adapted to be disposed on the head of a person;

sensor and receiving means associated with said head set means for automatically sensing and receiving an infrared radiation signal and for providing a signal corresponding thereto;

speaker means associated with said head set means and connected to said sensor and receiving means for receiving the signal therefrom and for providing an acoustical signal corresponding to the sensed infrared radiation signal;

a voice microphone associated with said head set means and disposed to receive the person's voice and provide a voice signal corresponding thereto;

emitting means associated with said head set means and responsive to said voice signal for emitting infrared radiation corresponding to said voice signal; and

blocking means responsive to the signal from said sensor and receiving means for blocking said voice signal from reaching said emitting means whenever the infrared radiation signal is sensed, whereby the infrared radiation communication apparatus may not emit infrared radiation when an infrared radiation signal is being sensed and received.

2. An infrared radiation communication apparatus as described in claim 1, additionally comprising:

a noise sensing microphone associated with said head set means and dis-

posed to receive ambient noise and provide a noise signal corresponding thereto; and

means responsive to said voice signal and said noise signal for providing a signal to said blocking means when the level of the voice signal is below a threshold corresponding to the level of the noise signal, said blocking means being responsive to said signal for blocking said voice signal so that the voice signal is only passed to the emitting means when it is above the threshold established by the noise signal.

3. An infrared radiation communication apparatus as described in claim 1, wherein the means for emitting infrared radiation includes diodes driven by a constant current generator so that the intensity of the emitted radiation remains constant.

4. An infrared radiation communication apparatus as described in claim 1, wherein the means for emitting infrared radiation is attached to said head set means and is disposed in said head set so that maximum radiation is provided in the direction in which the person carrying the head set is facing.

5. An infrared radiation communication apparatus as described in claim 1, additionally comprising means for dividing said voice signal into pulses of short duration, which pulses are provided to the means for emitting infrared radiation.

6. An infrared radiation communication apparatus as described in claim 1, additionally comprising:

means for receiving a frequency modulated radio signal and for providing a signal corresponding thereto; and

means for selectively connecting said signal to the receiving means of said sensor and receiving means whereby the receiving means provides a signal corresponding to the frequency modulated radio signal to the speaker means.

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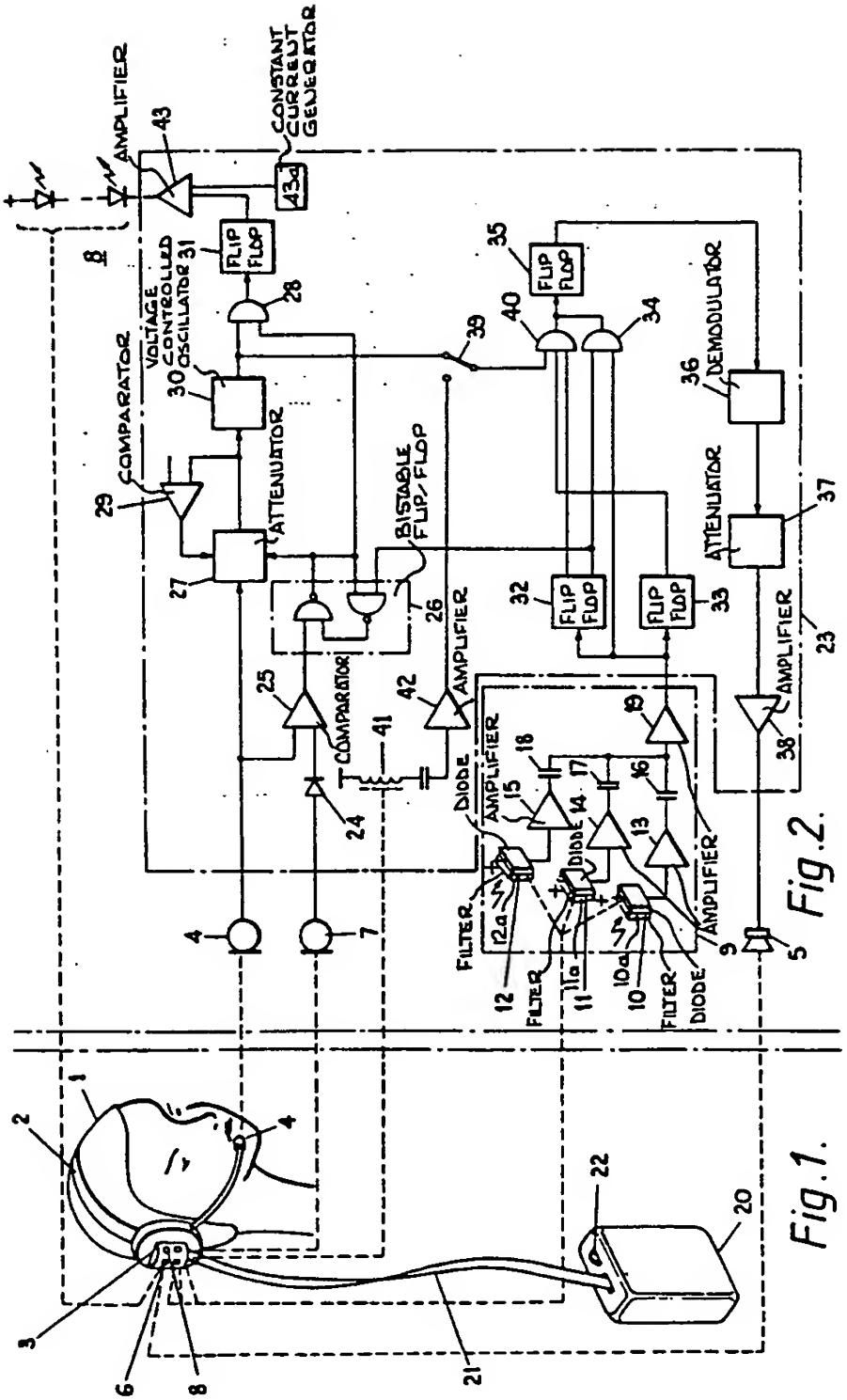

Fig.2.

Fig.1.

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